Nota Lepi. **39**(2) 2016: 85–91 | DOI 10.3897/nl.39.8087

Records of host ant use of *Phengaris* Doherty, 1891 (Lepidoptera, Lycaenidae) in the Czech Republic

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http://zoobank.org/D878AD86-57DB-4D26-83C0-32B963D729FC

Received 9 February 2016; accepted 12 May 2016; published: 13 June 2016
Subject Editor: Thomas Schmitt.

Abstract. The specificity of the specialisation of *Phengaris* Doherty, 1891 caterpillars to their host ants is still not fully understood. In this report, we summarize all available records of *Phengaris* in ant nests from the Czech Republic. *P. alcon* (Denis & Schiffermüller, 1775) was found exclusively in nests of *Myrmica scabrinodis* Nylander, 1846 at four sites, and one *P. nausithous* (Bergsträsser, 1779) caterpillar was found in a nest of *M. scabrinodis*. According to published records, *P. nausithous* may use *M. scabrinodis* at the edges of its range but should be adapted exclusively to *M. rubra* (Linnaeus, 1758) in the centre of its range. No records of *P. arion* (Linnaeus, 1758), *P. teleius* (Bergsträsser, 1779) and *P. alcon* populations feeding on *Gentiana cruciata* (Gentianaceae) ("*P. rebeli*") are available from the Czech Republic.

Introduction

Phengaris Doherty, 1891 (=*Maculinea* van Eecke, 1915) butterflies are among the most studied insects in Europe due to both their vulnerability and unique myrmecophilous life habits (Settele et al. 2005). Females lay eggs on the flowers of species-specific host plants, and hatched caterpillars feed on unripe seeds inside the flowers. After the first three instars, caterpillars leave their host plants and fall to the ground, where they are immediately adopted by ants of the genus *Myrmica* Latreille, 1804. Then, caterpillars feed on ant brood or mimic ant larvae and are fed directly by ant workers. They overwinter once or twice inside ant nests before they pupate (Chapman 1916; Settele et al. 2005).

The level of *Phengaris* specialisation on host ant species has been much discussed during the past few years. According to previous thinking, each species (or population) of *Phengaris* should be specialised to one species of *Myrmica* as their "primary host" and possibly one or several more species as "secondary host" ants (Thomas et al. 1989; Settele et al. 2005). The survival of caterpillars should be much higher in the nests of primary hosts than in the nests of secondary hosts. Caterpillars may be adopted by many ant species, but they die in nests of non-host ants. As more records of caterpillars in *Myrmica* nests have appeared, however, the intimacy of the *Phengaris* specialisation has become questioned (Pech et al. 2007). Today, the level of specialisation and character of the *Phengaris-Myrmica* host system is still not completely understood (Filz and Schmitt 2015) and new data are needed for future analyses.

Most *Phengaris* host specificity data were obtained in central and eastern Europe, especially in Poland and Hungary (Stankiewicz et al. 2005; Tartally et al. 2008; Tartally and Varga 2008; Witek et al. 2008; Sielezniew and Dziekańska 2009; Sielezniew and Stankiewicz-Fiedurek 2009). The

use of this information is quite problematic for *Phengaris* populations in other parts of Europe, because the *Phengaris* host specificity shows geographical variability, at least in some cases (Als et al. 2002; Stankiewicz et al. 2005). For example, *M. scabrinodis* Nylander, 1846 is the most common host of *P. alcon* (Denis & Schiffermüller, 1775) in central Europe, but not used in development of caterpillars at all in Denmark (Als et al. 2002).

The area of the Czech Republic is very interesting from a biogeographical point of view as a result of quarternary history. The ranges of many closely related species from different taxa (originating from a common ancestor in refugees of southern Europe during the last glacial) meet in or close to the Czech Republic, e.g. snails (Horsák and Novák 2005), slow worms (Gvoždík et al. 2010), hedgehogs (Bolfíková and Hulva 2012), as well as ants (Seifert 1995; Schlick-Steiner et al. 2006) and butterflies (Konvička et al. 2008). Knowledge of the host specificity of *Phengaris* blues in the Czech Republic (as well as in Germany) will add a potentially interesting piece to the mosaic of the *Phengaris-Myrmica* system. We have tried to summarize all published records of *Phengaris* caterpillars in ant nests available from the Czech Republic and unpublished records from Czech lepidopterologists and other conservationists interested in *Phengaris* blues. Because there is only one paper dealing with *Phengaris* host specificity data from the Czech Republic (Witek et al. 2008) and we can not find anyone having unpublished records available, we have decided to publish data (however scarce) from our field research. Although our data are far from complete and exhaustive, we believe that even anecdotal records may contribute to the mosaic of our present knowledge about the geographical variation of *Phengaris* host specificity.

Methods

All searched sites of *P. alcon* (Placy, Mečichov, Jindřichovice, Nahošín) and *P. nausithous* (Bergsträsser, 1779) (Josefov) are wet meadows with *Molinia caerulea* L. (Moench) (Poaceae) as a dominant component. In Placy (central Bohemia, 49°40'N, 14°06'E), five plots (1×2m, all in the close vicinity of *Gentiana pneumonanthe* L., Gentianaceae) were searched. All nests in the plots were opened using a garden rake to collect a sample of ants and to check for the presence of *Phengaris* at the surface. In Jindřichovice (49°23'N 13°51'E) and Nahošín (49°21'N 13°50'E) (both south-western Bohemia), 10 whole nests from the vicinity of host plants (*G. pneumonanthe* or *Sanguisorba officinalis* L., Rosaceae) were dug out and searched through in the lab. In Mečichov (49°20'N, 13°47'E; south-western Bohemia), many ant nests were opened using a garden rake in 2000–2001, with nests checked in a 325 m^2 area independently of the position of host plants. This research was not aimed at studying the *Phengaris* host specificity and the numbers of infested ant nests were not recorded precisely; thus, these results are not useful for quantitative analysis. To obtain some basic quantitative data, 15 whole nests were dug out and searched in the same manner as in Jindřichovice and Nahošín. In Josefov (eastern Bohemia, 50°20'N, 15°55'E), a caterpillar was found incidentally during the investigation of two *Myrmica* nests, which were dug out and searched through in the lab to count ant workers and juveniles.

Results and discussion

There are very few records of *Phengaris* caterpillar or pupae in *Myrmica* nests from the Czech Republic. In addition, there are as yet no records of *P. arion* (Linnaeus, 1758) or *P. alcon* popula-

tions feeding on *Gentiana cruciata* L. (Gentianaceae) ("*P. rebeli*") (see Kudrna and Fric (2013) and Tartally et al. (2014) for a recent view on taxonomical status and biology of *P. alcon* and *P. rebeli* (Hirschke, 1904)).

Witek et al. (2008) published data from two localities of *P. teleius* (Bergsträsser, 1779) from the Czech Republic. *M. scabrinodis* was the only recorded host ant, but as *P. teleius* commonly develops in nests of many *Myrmica* species (Pech et al. 2007; Witek et al. 2008), these exclusive records from *M. scabrinodis* nests are clearly related to the low number of observations and other host ants cannot be ruled out.

Several records of *P. alcon* and one of *P. nausithous* were obtained by our field research (Table 1; Fig. 1). *P. alcon* used *M. scabrinodis* as a host at all four localities (Fig. 2). In addition to the data in Table 1, 260 nests of *M. scabrinodis*, 61 of *M. ruginodis* Nylander, 1846, four of *M. vandeli* Bondroit, 1920, three of *M. rubra* (Linnaeus, 1758) and in total 54 nests of non-*Myrmica* ants

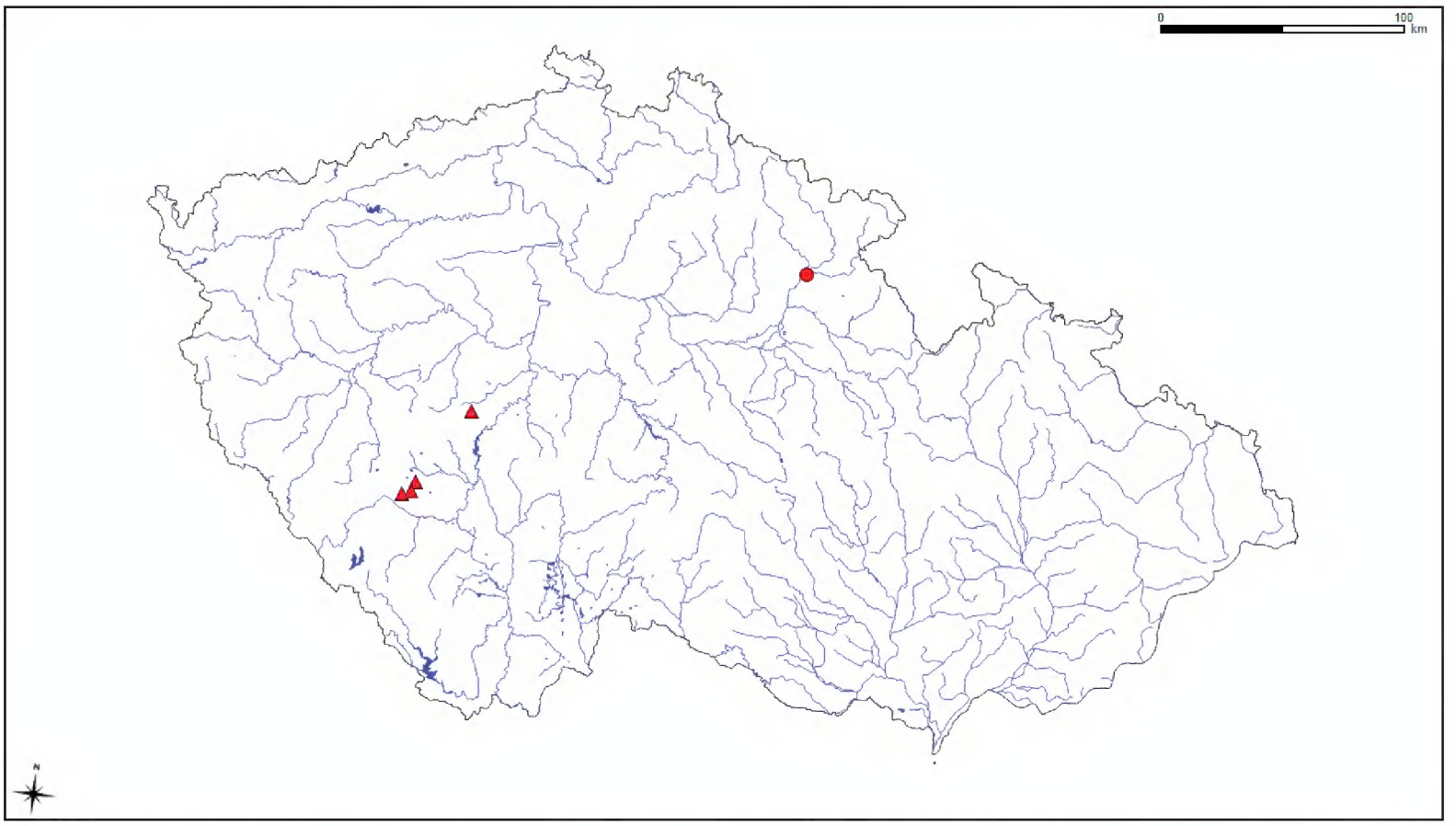

Figure 1. Location of sites where records of caterpillars of *P. alcon* (triangles) and *P. nausithous* (circles) in ant nests are known in the Czech Republic.

Table 1. Records of *P. alcon* and *P. nausithous* caterpillars in ant nests in the Czech Republic.

Site	*Phengaris*	*Myrmica*	Searched nests	Infested nests	Total number of caterpillars/pupae	Source
Placy	*P. alcon*	*M. scabrinodis*	16	1	3	Pech, Sedláček, Henebergová, Kupková, 1.7.2015. unpubl.
		M. ruginodis	1	-	-	
Mečíchov		*M. scabrinodis*	15	3	6	Pech, Křenová, Janda, May 2001, unpubl.
Jindřichovice		*M. scabrinodis*	10	3	7	Pech, Křenová, Janda, May 2001, unpubl.
Nahošín		*M. scabrinodis*	10	1	1	Pech, Křenová, Janda, May 2001, unpubl.
Josefov	*P. nausithous*	*M. scabrinodis*	2	1	1	Pech, 19.12.2012, unpubl.

Figure 2. Pupae of *P. alcon* in a *M. scabrinodis* nest. Locality Placy near Příbram in Central Bohemia, 1 July 2015. Photo: Ondřej Sedláček.

(*Lasius niger* (Linnaeus, 1758), *L. platythorax* Seifert, 1991, *L. flavus* (Fabricius, 1782), *Formica fusca* Linnaeus, 1758 and *F. polyctena* Förster, 1850) were opened in Mečichov in 2000–2001. We found many nests of *M. scabrinodis* infested by *P. alcon*, but no other ants hosting these caterpillars at this locality. Unfortunatelly, the presence of caterpillars in ant nests was not recorded precisely to allow quantitative analysis, but the observations correspond to the published data, because *M. scabrinodis* is the most common host of *P. alcon* in central Europe, although *P. alcon* is able to develop in the nests of many *Myrmica* ants (Pech et al. 2007; Witek et al. 2008; Sielezniew and Stankiewicz-Fiedurek 2009; Sielezniew et al. 2015).

Interestingly, a single caterpillar of *P. nausithous* was found in a *M. scabrinodis* nest in Josefov (Fig. 3). *P. nausithous* is the *Phengaris* species with the lowest number of known *Myrmica* hosts (two species only). It usually parasitizes nests of *Myrmica rubra* (Thomas et al. 1989; Tartally and Varga 2005; Witek et al. 2008), and the only other known host species of *P. nausithous* is *M. scabrinodis*. However, there are very few such records, all of them from the southwestern or eastern edge of the European range of *P. nausithous* (Munguira and Martín 1999; Witek et al. 2008; Tartally et al. 2008, 2010). According to Jansen et al. (2012), *P. nausithous* may depend on *M. rubra* in the centre of its range, whereas populations at the edges of its range may use *M. scabrinodis*. The caterpillar was found in December, 3–4 months after the adoption by ants. Because *Phengaris* caterpillars can be adopted by many ants (including non-host species) (Thomas et al. 1989), but then later die in their nests, our finding may be such a case. However, this is contradicted by the data of Patricelli et al. (2010), who

Figure 3. The locality near Josefov, Eastern Bohemia, where the caterpillar of *Phengaris nausithous* was found in a nest of *Myrmica scabrinodis*. Photo: Pavel Pech.

found that *P. nausithous* juveniles died in nests of non-host *Myrmica* ants within one month of adoption. Thus we suggest that it is legitimate to consider *M. scabrinodis* as a true host of this caterpillar.

The host specificity of *P. nausithous* and its relationship to host ants thus may be more complicated than previously thought. Our record in Josefov shifts the use of *M. scabrinodis* 200 kilometres closer to the heart of the European distribution of *P. nausithous* according to Wynhoff (1998). Unfortunately, there are almost no other data from this part of the *P. nausithous* distribution. It should be noted that *P. nausithous* is sometimes common at sites where *M. rubra* is absent or rare (Czech Republic - pers. observation; Netherlands - Jansen et al. 2012), and, if present, the infestation of *M. rubra* nests by *P. nausithous* is usually low (Tartally and Varga 2005; Witek et al. 2008). In such situations, it is unclear whether a rich population of *P. nausithous* can be supported. At the moment, the relationship of *P. nausithous* to *Myrmica* remains to be fully elucidated.

Acknowledgements

We are obliged to Kristýna Henebergová, Barbora Kupková, Milan Janda and Zdenka Křenová for help in the field and Marcin Sielezniew and an anonymous referee for valuable comments on a previous version of the paper. David Hardekopf improved the English of the paper and Jan Košnar made the map. The research was partially supported by the Ministry of Education, Youth and Sports of the Czech Republic, research project no. 2114/2014.

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